REMARKS/ARGUMENTS

The claims are 1 and 4-10. Claim 1 has been amended to better define the invention and to incorporate the subject matter of claim 3 (including claim 2 on which claim 3 previously depended). Accordingly, claims 2 and 3 have been canceled. Reconsideration is expressly requested.

Claims 1-3 and 5-6 are rejected under 35 U.S.C. §102(b) as being anticipated by *Galvanauskas et al. U.S. Patent No. 5,847,863*. The remaining claims were rejected under 35 U.S.C. 103(a) as being unpatentable over *Galvanauskas et al.* alone (claim 4) or further in view of *Richardson et al. U.S. Patent Publication No. 2003/0156605* for the reasons set forth on pages 3-7 of the Office Action, which essentially repeat the rejection the Examiner previously made in the last Office Action.

The Examiner has also stated that in his view, *Galvanauskas et al.* has a self-broadening spectrum because the *Agrawal* publication, "Fiber Optic Communication Systems", is said to teach that self-phase modulation inherently broadens the spectrum of any signal above a certain power, and also to teach how to calculate the signal power at which cross-phase modulation is not

a problem. The Examiner has also indicated that the arguments presented in the previous amendment regarding the differences in the steps taken to change the width and height of the gain spectrum were not persuasive because these differences were said not to be recited in the main claim 1.

In response, Applicants have amended claim 1 to better define the invention and to incorporate subject matter previously appearing in claims 2 and 3 and respectfully traverse the Examiner's rejection for the following reasons:

As set forth in claim 1 as amended, Applicants' invention provides a device for amplifying light pulses including a pulsed laser light source for producing light pulses having an optical spectrum, an optical stretcher coupled to the light pulses emitted by the laser light source, and an optically pumped amplifier fiber arranged to receive the light pulses from the optical stretcher. The optical stretcher precedes the amplifier fiber, includes an optical fiber having a negative group velocity dispersion, and temporally stretches the light pulses of the pulsed laser light source. The amplifier fiber has a positive group velocity dispersion and non-linear optical properties. The amplifier fiber amplifies and temporarily compresses the light

pulses and broadens the optical spectrum of the light pulses during amplification of the light pulses by taking advantage of non-linear self-phase modulation.

In accordance with Applicants' device as recited in claim 1 as amended, low-power light pulses are produced by means of a laser light source. These light pulses are then stretched by means of an optical stretcher. As recited in claim 1 as amended, the optical stretcher is an optical fiber having a negative group velocity dispersion. A pumped amplifier fiber follows the optical stretcher. In contrast to the fiber of the optical stretcher, the optical amplifier fiber has a positive group velocity dispersion. The amplifier fiber has non-linear optical properties that ensure that the spectrum of the light pulses is changed during amplification. The positive group velocity dispersion of the amplifier fiber ensures compensation of the negative group velocity dispersion of the optical stretcher, so that the light pulses are compressed at the same time during the amplification process. As a result, light pulses with a broad optical spectrum and high power are achieved.

None of the cited references discloses or suggests a device for amplifying light pulses having a structure recited in claim 1

as amended, or teaches a device that has an optically pumped amplifier fiber suitable for broadening the spectrum of the light pulses, and amplifying and temporally compressing the light pulses as well.

The primary reference to *Galvanauskas et al.* simply discloses a conventional chirped pulse amplification (CPA) system, in which the light pulses of a laser light source are first stretched by means of an optical stretcher. This stretching ensures that the duration of the light pulses is increased and the power is reduced. The stretched light pulses are then passed to an optical amplifier. The light pulses exit from the optical amplifier in amplified form, specifically with an unchanged pulse duration. The light pulses are compressed by means of an optical compressor that follows the amplifier, so that they are given a corresponding short pulse duration. The principle of CPA therefore involves first stretching the light pulses, then amplifying them, and finally recompressing them. The reason for this method of procedure is that non-linear optical effects are supposed to be avoided during the amplification process. See column 1, line 5 to column 2, line 25 of *Galvanauskas et al.*

In contrast to the conventional CPA system, as is described in *Galvanauskas et al.*, in Applicants' device as recited in claim 1 as amended, amplification takes place in the amplifier fiber, and at the same time, compression as well as spectral broadening of the light pulses takes place. The system described in *Galvanauskas et al.* is fundamentally different. Column 4 from line 10 to line 17 of *Galvanauskas et al.* explicitly emphasizes that <u>no</u> compression takes place within the amplifier in his system. Furthermore, *Galvanauskas et al.* at column 18, lines 20 to 27, emphasizes that the light pulses have a spectrum that is <u>narrowed</u> by a factor of 3 after amplification. This effect, also called "gain narrowing," runs precisely counter to Applicants' invention as recited in claim 1 as amended.

It is respectfully submitted therefore that Applicants' device as recited in claim 1 as amended, takes a fundamentally different path than the CPA system described in *Galvanauskas et al.* In the case of *Galvanauskas et al.'s* system, non-linear effects in the amplifier fiber are supposed to be avoided; however, these effects are precisely what are important according to Applicants' device as recited in claim 1 as amended. In Applicants' system as recited in amended claim 1, the amplifier fiber fulfills three functions at the same time, namely

amplification of the light pulses, spectral broadening of the light pulses due to non-linear effects, and compression of the light pulses.

Although the Examiner has taken the position that spectral broadening also takes place within the amplifier of *Galvanauskas et al.*, it is respectfully submitted that the Examiner is incorrect. As explained above, amplification causes spectral narrowing ("gain narrowing") in the *Galvanauskas et al.*'s system.

Claim 1 has been amended to incorporate the subject matter of previous claim 3, which makes clear that Applicants' device as recited in claim 1 as amended, includes a combination of a fiber with negative group velocity dispersion, which serves as an optical stretcher, and a subsequent amplifier fiber with positive group velocity dispersion. As mentioned previously, the amplifier fiber simultaneously fulfills the function of an optical compressor, which is fundamentally different from the *Galvanauskas et al.*'s system. In *Galvanauskas et al.*, it is explicitly stated in column 2, lines 14 to 16 that optical fibers cannot be used for optical compression of the (amplified) light pulses, specifically due to the non-linear optical effects that

occur in the fiber, which are supposed to be avoided there; however, it is precisely these non-linear optical effects that Applicants' device as recited in claim 1 as amended, takes advantage of to broaden the optical spectrum of the light pulses.

Although the Examiner refers to column 4, lines 1-17 of *Galvanauskas et al.*, as support for his position that *Galvanauskas et al.* discloses an optical stretcher comprising an optical fiber having negative group velocity dispersion, there is no disclosure or suggestion in this portion cited by the Examiner of an optical fiber with negative group velocity dispersion for use as an optical stretcher. All that is explained by this portion of *Galvanauskas et al.* is that different types of optical stretchers and compressors have different group velocity dispersions. Obviously, what is meant here is optical gratings as dispersive elements, as they are described in *Galvanauskas et al.*, for example in column 1, line 46 to column 2, line 7.

In any event, *Galvanauskas et al.* fails to disclose or suggest a device for amplifying light pulses as recited in claim 1 as amended, in which a fiber with a negative group velocity dispersion as an optical stretcher is combined with a pumped

amplifier fiber with positive group velocity dispersion. In fact, *Galvanauskas et al.* teaches away from that combination. As explained above, *Galvanauskas et al.* explicitly emphasizes that fibers are not supposed to be used for compression of the light pulses, because of the non-linear effects that occur.

Although the Examiner has also taken the position that he need not consider certain distinguishing characteristics recited in Applicants' claims, which he considers process limitations, it is respectfully submitted that before a device can be said to anticipate or render obvious Applicants' device, the prior device must at least be suitable for carrying out the claimed functions. In contrast to Applicants' device, however, *Galvanauskas et al.*'s system of optical fibers is entirely unsuitable for broadening the spectrum of the light pulses. In fact, in *Galvanauskas et al.*'s system, the spectrum is narrowed during amplification ("gain narrowing," as discussed above). Another fundamental difference between Applicants' device and the device of *Galvanauskas et al.* is that *Galvanauskas et al.*'s amplifier does not provide for compression of the light pulses. Rather, compression takes place only by means of the separate grating

compressor (reference number 40 in Figure 1a in *Galvanauskas et al.*), which follows the optical amplifier.

The *Agrawal's* publication relied on the Examiner in an attempt to buttress his position, fails to remedy the defects and deficiencies of *Galvanauskas, et al.* The Examiner has apparently of the opinion that every medium has non-linear optical effects in the sense of Applicants' claim 1, so that *Galvanauskas, et al.'s* system can also be assumed to have these properties and the effects resulting from them. It is respectfully submitted that this assessment is entirely beside the point. Non-linear effects occur to a practically relevant degree only in the case of high light intensities. In the case of a CPA system as described in *Galvanauskas, et al.*, such non-linear effects are specifically supposed to be avoided within the optical amplifier. For this purpose, the light pulses are stretched, in terms of time, before they are coupled into the amplifier. The stretching, in terms of time, is connected with a corresponding reduction in the intensity of the light pulses. After amplification, recompression then takes place, by means of a separate compressor.

In contrast to *Galvanauskas, et al.'s* system, in Applicants' device as recited in claim 1 as amended, non-linear optical effects in the amplifier are taken advantage of in targeted manner. It is precisely these effects that are avoided in *Galvanauskas, et al.'s* system in a targeted manner. In order for Applicants' device to take advantage of these effects, the optical amplifier fiber has a positive group velocity dispersion, as recited in claim 1 as amended, by means of which the negative group velocity dispersion of the optical stretcher is compensated. It is respectfully submitted that a person skilled in the art would never consider such a combination of dispersive elements in the case of *Galvanauskas, et al.'s* system. As explained above, in the case *Galvanauskas, et al.'s* system, the use of a fiber for compression of the light pulses is explicitly undesirable. Non-linear effects within the compressor and, in particular, also within the optical amplifier, are intended to be avoided in the case of the *Galvanauskas et al.'s* CPA system.

The remaining reference to *Richardson et al.,* which has been cited against claims 7-10, has been considered but is believed to be no more relevant. Although FIG. 2 of *Richardson et al.* discloses a laser oscillator forming part of a pulse light source

in which pulses pass from the oscillator to the pulse selector 52, there is no disclosure or suggestion of a device for amplifying light pulses including an optically pumped amplifier fiber, which amplifies and temporally compresses light pulses and broadens the optical spectrum of a light pulse during amplification of the light pulses by taking advantage of non-linear self-phase modulation.

Accordingly, it is respectfully submitted that claim 1 as amended is patentable over the cited references together with claims 4-10, which depend directly or indirectly thereon.

In summary, claim 1 has been amended, and claims 2-3 have been canceled. In view of the foregoing, it is respectfully requested that the claims be allowed and that this case be passed to issue.

Respectfully submitted,
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